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Opinion

Gadolinium Toxicity on Marine Organisms

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Aquatic organisms are exposed to several adverse changes in their environment that they are able to sense as stressful insults. The source of the environmental stress can be either natural or anthropogenic. During the last centuries, quality of water resources has been deteriorating because of the continuous addition of several different types of pollutants. Some contaminants are non-degradable and persist in the environment for long periods. This can cause long-term effects in tissues and organs of aquatic organisms that can accumulate high levels of pollutants [1]. Chemical contaminants have been a continuous source of evolutionary challenges throughout living organisms life history. Human-driven pollution increased the rate of change of contemporary environment, challenging the adaptive potential of many species. Empirical data on the evolutionary potential of various species are needed to determine their adaptation to a changing world.

Pharmaceuticals are increasingly being employed in human medicine and may pollute the marine environment because wastewater treatment plants don't remove these compounds adequately. Recently the International Conference on Chemicals Management (ICCM) highlighted the urgent need for global cooperation to build awareness and start actions to address drug pollution [2]. During drug treatment, active components of pharmaceuticals are excreted from the patient body and subsequently introduced into wastewater. Wastewater treatment plants are not designed to remove pharmaceutical compounds, that are sometimes ineffectively filtered and enter into the aquatic environment with severe effects on the physiology of various organisms. Rare elements used in medical applications, such as Gadolinium (Gd), a metal of the lanthanide series of the elements, are released into municipal waste water and then discharged into aquatic and marine environments. Since the 1980s, chelates of Gd have been used as contrast agents for magnetic resonance imaging (MRI) and were first considered safe for humans, until they were linked to nephrogenic systemic fibrosis (NSF) disease. Gd anthropogenic pollution is referred to as "positive Gd anomaly", meaning a positive ratio between the measured Gd concentration in a sample and the background Gd concentration, naturally occurring due to geological processes. Positive Gd anomalies were observed in several lakes, rivers, and seawater from various locations [3]. While natural Gd is present as weak organic complexes, no information is available about anthropogenic Gd speciation and the Gd anomaly is calculated using the total Gd concentration in the sample [3]. All over the world, Gd anomalies from seawater around intensely populated urban areas have greatly increased over time, demonstrating that Gd anomalies are due to the release from anthropogenic sources [4,5].

My previous work demonstrated the harmful effects of exposure to Gadolinium (Gd) on the development of four geographically and phylogenetically distant sea urchin species (two from Europe and two from Australia), demonstrating not only the toxic effects of gadolinium at environmentally relevant concentrations, but also the effects induced at the cellular and molecular levels, posing particular interest to the consequences on the biomineralization process and on the defense strategies. Morphological aberrations mainly alter skeleton growth, strongly affecting the biomineralization process. The four sea urchin species, geographically and phylogenetically distant, had different sensitivity to Gd, but the effect of this agent on larval phenotype was similar [6]. This demonstrated that the same pollutant can have very different toxicity levels on marine organisms, even within the same taxonomic group, showing that using only one model organism to test the effects of pollutants on the marine environment is not sufficient. Therefore, results of pollution assays based on one species within a taxon can be misleading with respect to hazard risk assessment.

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